MODELLED INTERANNUAL CHANGES IN OCEAN BOTTOM PRESSURE

Victor **ZLOTNICKI**, I. **FUKUMORI** and D.**MENEMENLIS**
Jet Propulsion Laboratory, California Institute of
Technology.
MS 300-323, 4800 Oak Grove Drive. Pasadena CA 91109.
USA.
vz@pacific.jpl.nasa.gov. (USA) 818-354-5519

ABSTRACT

We present estimates of possible interannual changes in ocean bottom pressure from the analysis of 18 years of ocean bottom pressure output from the JPL/ECCO model. These are spot-checked with Bottom Pressure Recorder data.

We first remove erroneous trends in the model, associated with the Boussinesq approximation. We then estimate and describe simple annual and semiannual cycles. Next, we compute EOFs and CEOFs of the component with periods > 1 yr and show that several interannual modes (EOFs and CEOFs) of BP signals are present and detectable with an instrument capable of resolving a few mm H2O changes averaged over ~500-1000 km, such as GRACE promises (http://ftp.csr.utexas.edu/grace). While most of the variability is associated with the Southern Ocean and N. Pacific, a mode exists in which the whole Pacific, Indian, and Southern basins participate, at the exclusion of the Atlantic, while in another mode, the Indian and N. Pacific have most of the energy.

There is also significant long-period energy at length scales shorter than ~ 1000 km, with implications for any program to compare GRACE to in-situ bottom pressure data.

FIG 1 illustrates the comparison between numerical model output and one BPR (bottom pressure recorder) in the Indian Ocean sector of the ACC. Notice that both short and long periods show correlation.

FIGs 2 and 3 summarize the comparison with BPRs in terms of the correlation coefficient (divided by 10 for display purposes). FIG 2 uses the unfiltered BPR and model record, while FIG 3 only considers a low-pass filtered version, periods longer than 30 days. Overall, the unfiltered comparison yields higher correlations, indicating that it is the short periods that are better matched. Whether this is a model deficiency, or due to the problems that BPRs have with long-term stability, is not known.

FIG 4 shows the annual cycle of bottom pressure in this model. Note that the scale is +/- 3 cm H2O (3 mbars), about 30 times the expected sensitivity of GRACE at scales longer than 1000 km.

FIG 5 displays the first 4 EOFs (empirical orthogonal functions, labelled from 0 to 3) of the model output, computed after trends and the seasonal cycle have been removed (otherwise, the trend and the seasonal cycle are the first two EOFs, forcing orthogonality with theur patterns). While the ACC and the N. Pacific, the most energetic regions, have most of the 'action', it is clear from EOF 1 that the Indian Ocean participates in these large-scale patterns. The maps are normalized to the -1 to +1 range, so the amplitude of the time series carries the units.

FIG 6 shows the standard deviations of bottom pressure over periods longer than 30 days, and those shorter than 30 days, as well as their ratio. One application of this map is in deciding where to place BPRs to 'calibrate' GRACE: it is desirable that the long period signal that GRACE can detect (> 30 days) not be overwhelmed by short period signal which, even after dealiasing with a barotropic or other numerical model, may still leak into the long period estimate. Thus, areas where the ratio long/short is large are more desirable.

FIG 7 shows the energy at spatial wavelengths shorter than about 1000 km. Notice that the color scale is 0 to 1 mbar, and that a large part of the ocean has more energy than 1 mbar. Again, the application of this plot is in deciding where to place BPRs to 'calibrate' GRACE: cost constraints

prevent a deployment of hundreds of instruments. Deploying ~ 10 BPRs in a region with ~ 0.3 mbar or lower std. deviation at short length scales guarantees that an average of the BPRs will not exceed a 0.1 mbar sampling error.

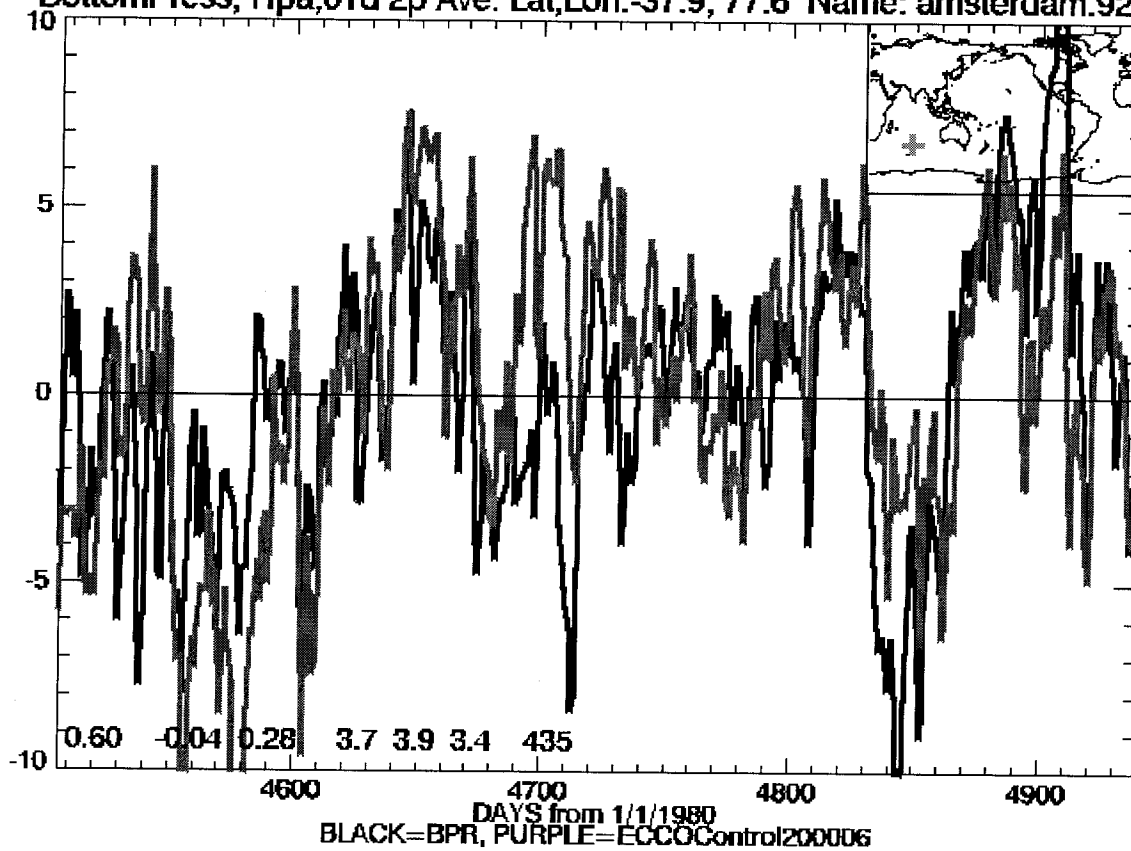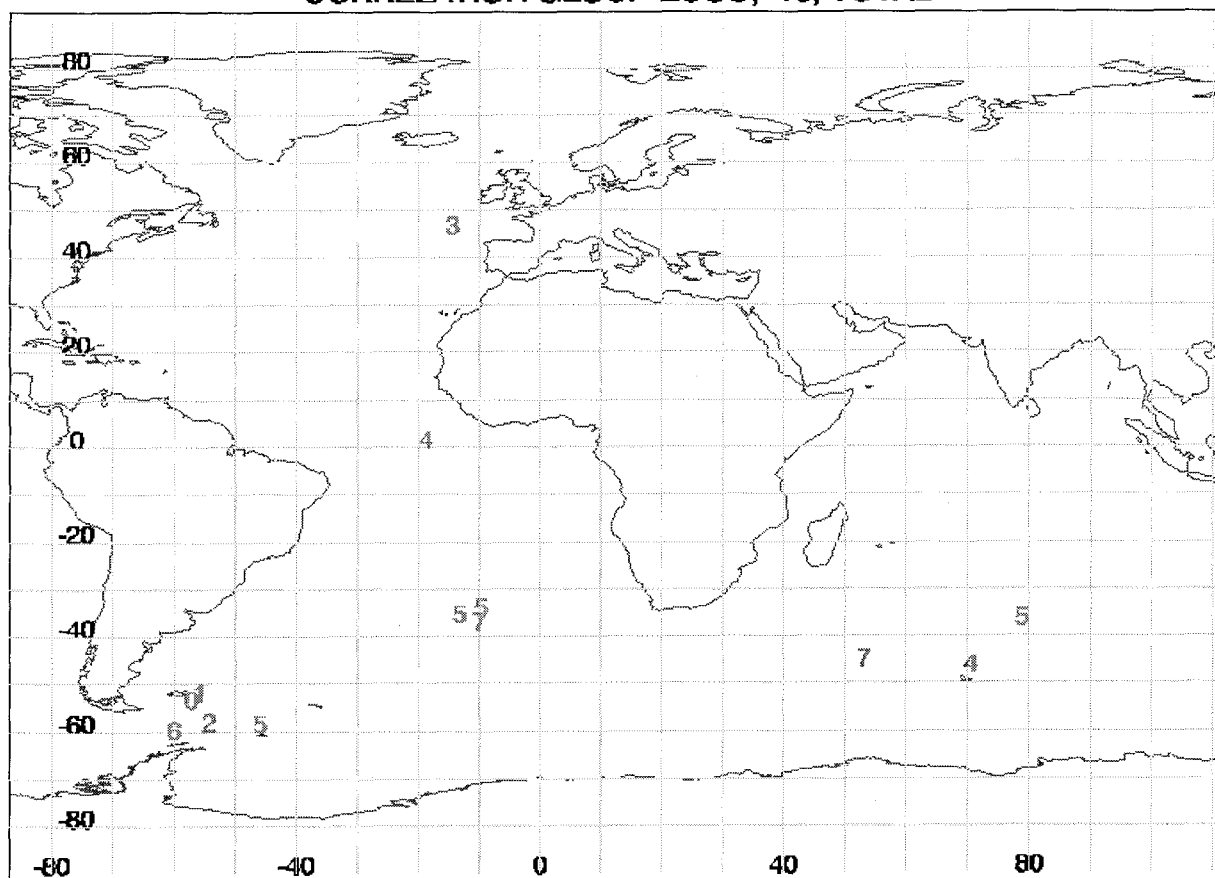BottomPress, Hpa,01d 2p Ave. Lat,Lon:-37.9; 77.6 Name: amsterdam.9293

0.60   -0.04 0.28   3.7 3.9 3.4   435

DAYS from 1/1/1980
BLACK=BPR, PURPLE=ECCOControl200006

FIG 1

CORRELATION GLOUP-ECCO,*10, TOTAL

FIG 2

CORRELATION GLOUP-ECCO,*10, LOWPASS(>30d (23d2p))

FIG 3
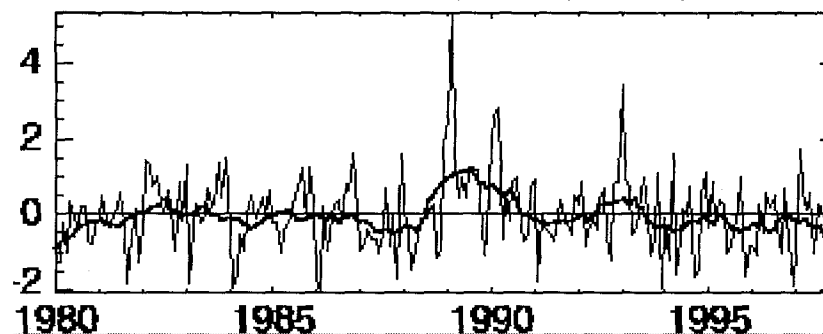
JAN ECCO BOTT PRESS, 18 YR AVE.
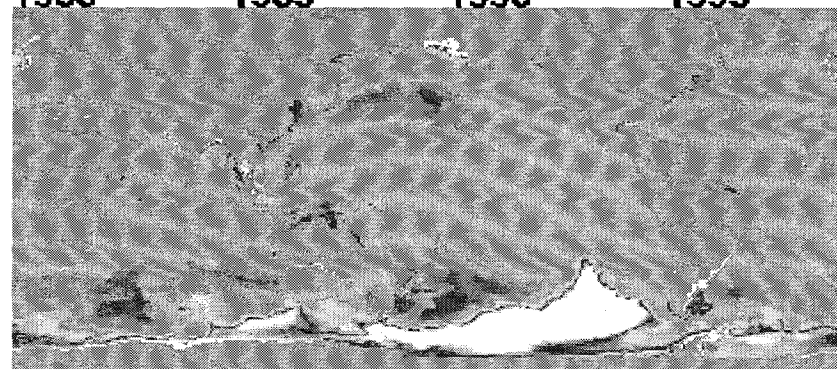
APR

JUL

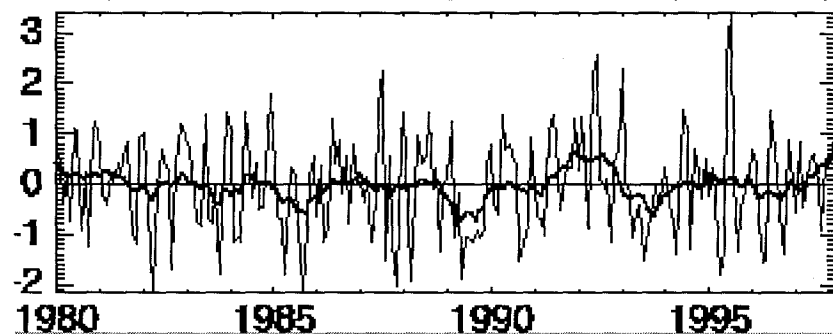OCT

BPress CM
-2   -1   0   1   2
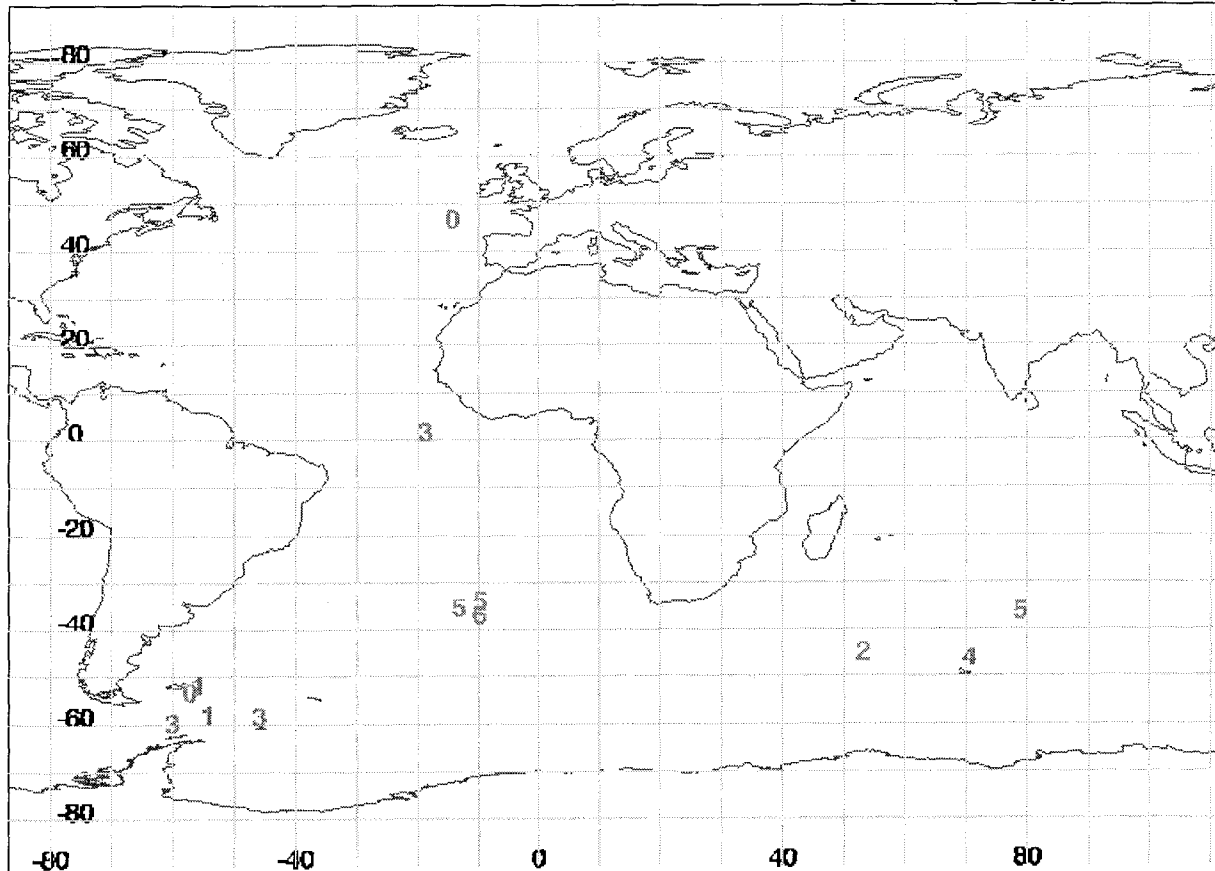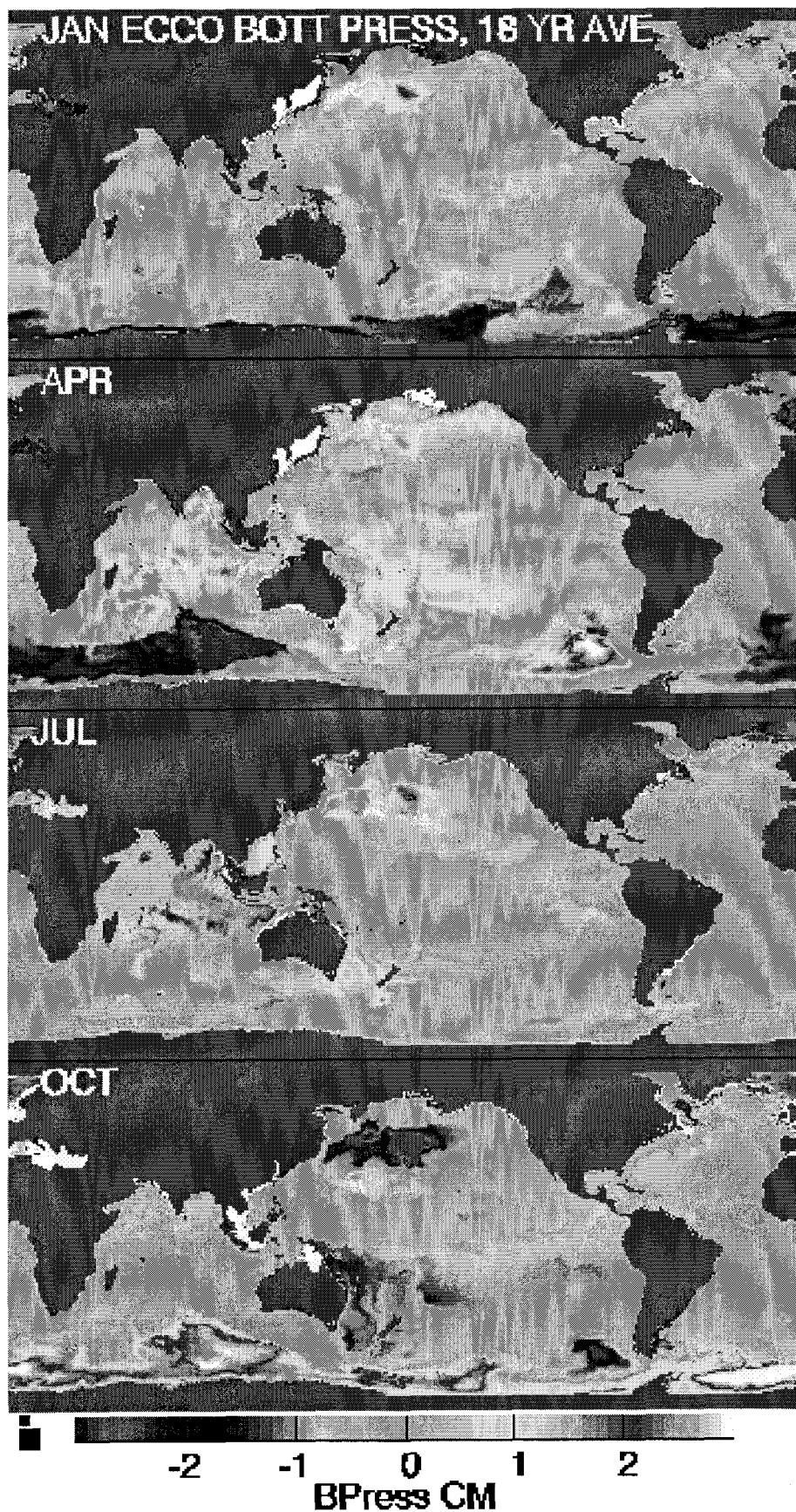
FIG4

EIGEN=0 PVar=11.6. Unit: CM H2C
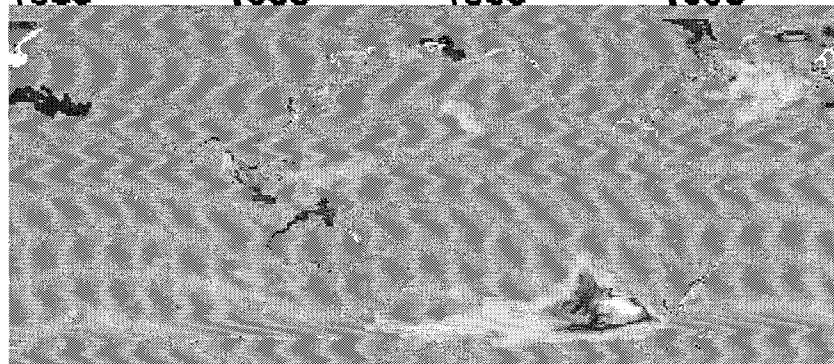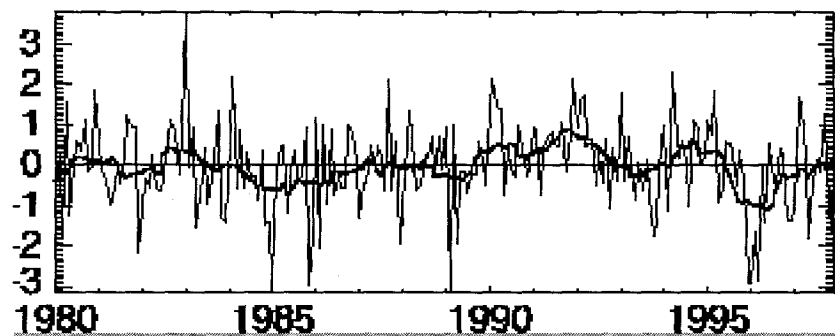
EIGEN=1 PVar=10.2. Unit: CM H2C
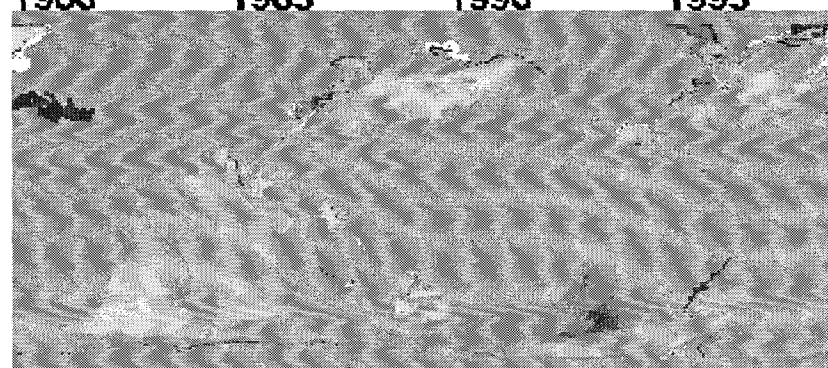
EIGEN=2 PVar= 9.7. Unit: CM H2O

EIGEN=3 PVar= 6.6. Unit: CM H2O

FIG5.

SD(BPRESS, T<30days)

SD(BPRESS, T>30days, detrended)

1   2   3   4   5
BOTTOM PRESS, CM H2O

RATIO LONG/SHORT

-2   -1   0   1   2
RATIO

FIG 6
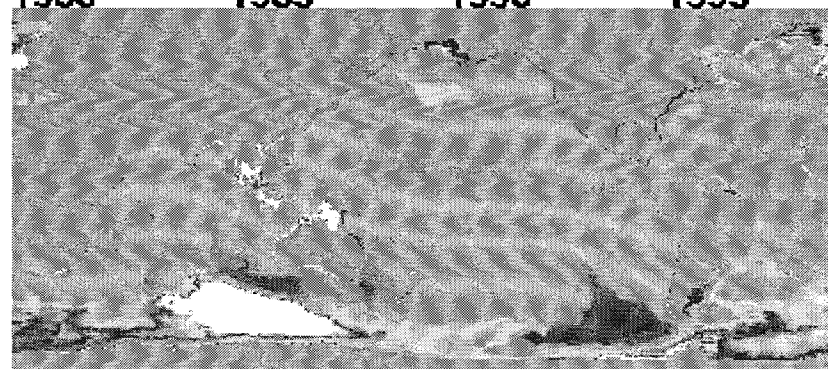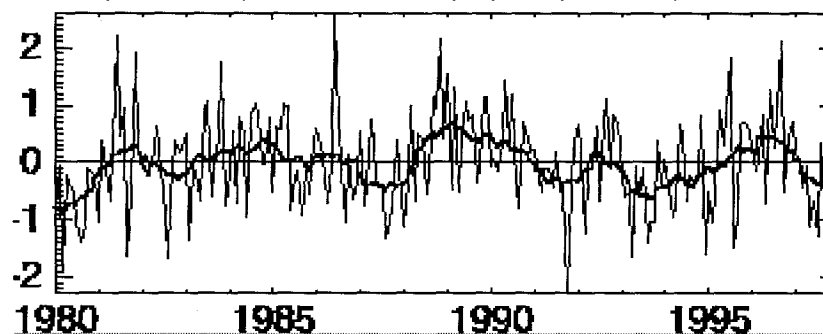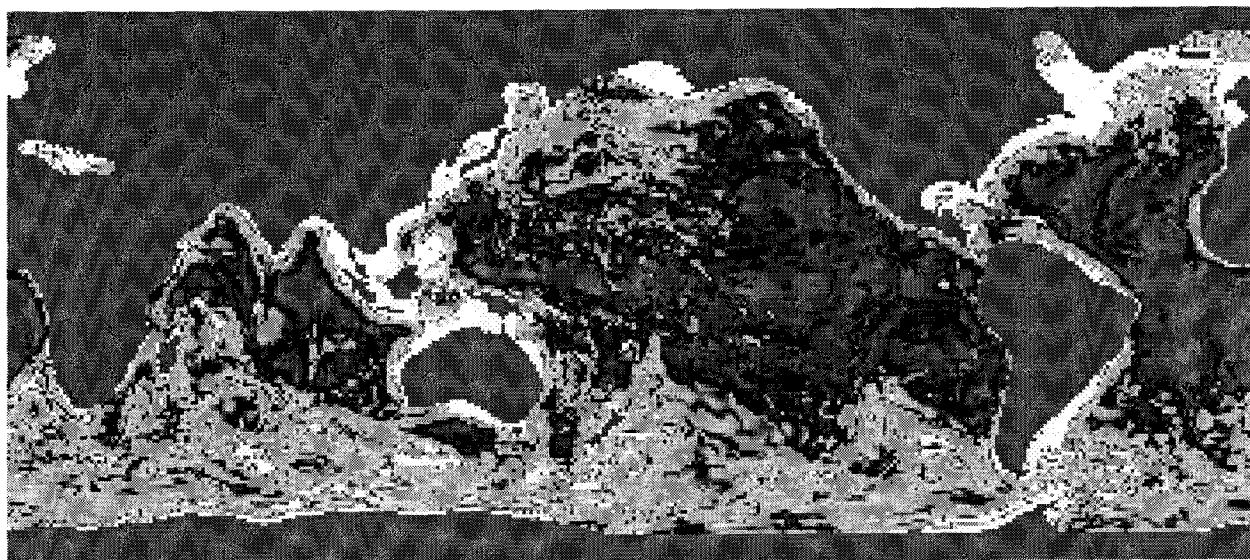
BOTT PRESS, MONTH-AVE, SHORT WAVEL: STDDEV(BP-10DcgAvc(BP)), mbar. ECCO CTL 2000-06

FIG 7